NEEDLE-FREE BLOOD DRAW

BACKGROUND

[0001] Unless otherwise indicated herein, the materials described in this section are not prior art to the claims in this application and are not admitted to be prior art by inclusion in this section.

[0002] A number of scientific methods have been developed in the medical field to evaluate physiological conditions of a person by detecting and/or measuring one or more analytes in a person's blood or other bodily fluids or tissues. The one or more analytes could be any analytes that, when present in or absent from the blood, or present at a particular concentration or range of concentrations, may be indicative of a medical condition or health state of the person. The one or more analytes could include enzymes, reagents, hormones, proteins, cells or other molecules, such as carbohydrates, e.g., glucose.

[0003] In a typical scenario, a person's blood is drawn and either sent to a lab or input into a handheld testing device, such as a glucose meter, where one or more tests are performed to measure various analyte levels and parameters in the blood. The frequency and regularity of such blood tests can depend on the type of test and the nature of the condition or conditions being monitored. For example, testing for blood glucose concentration for a person with diabetes may be performed relatively frequently.

SUMMARY

[0004] In one aspect, a device includes: an evacuated negative-pressure barrel with an aperture membrane sealing an aperture at a distal end of the evacuated negative-pressure barrel, and a housing affixed to, and sealing, a proximal end of the evacuated negative-pressure barrel; an accelerator barrel positioned lengthwise within the evacuated negative-pressure barrel with an open proximal end fixed to the housing and opening into a chamber within the housing, and having an open distal end proximate to, and aligned with, the aperture; a high-pressure gas source configured for filling the chamber with pressurized gas; a trigger valve situated between, and forming a hydrostatic boundary between, the chamber and the open proximal end of the accelerator barrel; a micro-particle positioned within the accelerator barrel at a launch point proximate to the trigger valve; and a trigger-valve release actuator configured for abruptly opening of the trigger valve to abruptly release the pressurized gas from the chamber and into the open proximal end of the accelerator barrel, wherein, the abruptly released pressurized gas is configured to accelerate the micro-particle from the launch point to the open distal end of the accelerator barrel and through the aperture with sufficient momentum to pierce through the aperture membrane and penetrate a sufficient depth of dermal tissue proximate to the distal end of the evacuated negative-pressure barrel to induce a micro-emergence of blood at the dermal tissue surface, and wherein, residual negative pressure within the evacuated negative-pressure barrel is configured to draw at least a portion of blood from the micro-emergence into the evacuated negative-pressure barrel through the pierced aperture membrane.

[0005] In another aspect, a device includes: an outer barrel with an aperture at a distal end, and a housing affixed to a proximal end; a hydrophilic absorptive wick in the outer barrel, unobstructively surrounding at least a portion of the aperture; an inner barrel positioned lengthwise within the outer barrel with an open proximal end fixed to the housing and opening into a chamber within the housing, and having an open distal end proximate to, and aligned with, the aperture; a high-pressure gas source configured for filling the chamber with pressurized gas; a trigger valve situated between, and forming a hydrostatic boundary between, the chamber and the open proximal end of the inner barrel; a micro-particle positioned within the inner barrel at a launch point proximate to the trigger valve; and a trigger-valve release actuator configured for abruptly opening of the trigger valve to abruptly release the pressurized gas from the chamber and into the open proximal end of the inner barrel, wherein, the abruptly released pressurized gas is configured to accelerate the micro-particle from the launch point to the open distal end of the inner barrel and through the aperture with sufficient momentum to penetrate a sufficient depth of dermal tissue proximate to the distal end of the outer barrel to induce a micro-emergence of blood at the dermal tissue surface, and wherein, the hydrophilic absorptive wick is configured to draw at least a portion of blood from the micro-emergence into outer barrel through the aperture by capillary action.

[0006] In still another aspect, a device includes: a negative-pressure barrel having an aperture opening at a distal end and a housing affixed to a proximal end; an accelerator barrel positioned lengthwise within the negative-pressure barrel with an open proximal end fixed to the housing and opening into a chamber within the housing, and having an open distal end proximate to, and aligned with, the aperture; a high-pressure gas source configured for filling the chamber with pressurized gas; a trigger valve situated between the chamber and the open proximal end of the accelerator barrel, the trigger valve having a closed operational state in which the trigger valve is closed so as to form a hydrostatic boundary between the chamber and the open proximal end of the accelerator barrel, and an open operational state in which the trigger valve is opened so as to remove the hydrostatic boundary; an arming actuator configured for setting the device in an armed operational state in which (i) the trigger valve is set in the closed operational state, (ii) the chamber is filled with pressurized gas, (iii) a micro-particle is positioned within the accelerator barrel at a launch point proximate to the trigger valve, (iv) a negative-pressure vacuum is created within the negative-pressure barrel and within the accelerator barrel between the open distal end and the closed trigger valve, and (v) an aperture membrane is configured to seal the aperture and maintain the negative-pressure vacuum; and a trigger-valve release actuator configured for causing the trigger valve to abruptly transition from the closed operational state to the open operational state, thereby abruptly releasing the pressurized gas from the chamber into the open proximal end of the accelerator barrel, wherein, the abruptly released pressurized gas is configured to accelerate the micro-particle from the launch point to the open distal end of the accelerator barrel and through the aperture with sufficient momentum to pierce through the aperture membrane and penetrate a sufficient depth of dermal tissue proximate to the distal end of the negative-pressure barrel to induce a micro-emergence of blood at the dermal tissue surface, and wherein, the negative-pressure vacuum within the negative-pressure barrel is configured to draw at least a portion of blood from the micro-emergence into the negative-pressure barrel through the pierced aperture membrane.